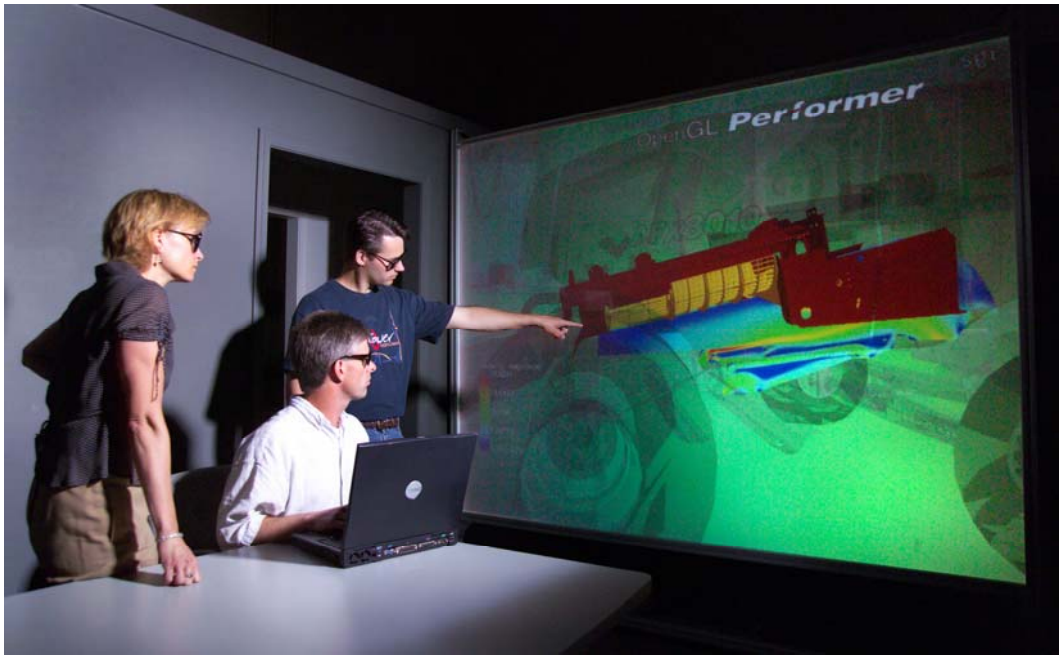
Computational Engineering & Simulation Laboratory



Using specially programmed 3-D virtual engineering software, scientists and engineers can save countless hours of mechanical design and test demonstrations to find workable solutions for delivering a sustainable feedstock of biomass for DOE's Office of Biomass.

Purpose

Biomass handling, separation, and fractionation processes can be characterized as gas/solid multi-phase flows with impacting moving boundaries. The physics of these types of processes are very complicated and present unique challenges for developing methods to characterize these flows and biomechanical loadings. Various computational tools including computational fluid dynamic, finite element stress analysis, and empirical correlations based on advanced experimental methods and measured data provide predictive insight into the behavior and physics of these types of processes for accomplishing the necessary biomass handling and preprocessing operations.

Research Goals

It is the goal of this research to develop predictive computational and experimental methods and tools for use in designing and evaluating biomass handling, fractionation and separation, and preprocessing technologies that are necessary to reduce the cost and increase the quality of biorefinery feedstocks.

Critical Linkages

The methods and tools developed through this feedstock/sugar interface R&D will link feedstock costs, quality, and sustainability metrics of harvesting, preprocessing, bulk handling, and storage systems to downstream pretreatment, hydrolysis, and fermentation operations.

The results of this feedstock/sugar interface R&D will help meet the programatic goal (C Level Milestone) of producing 150 million tons of cellulosic feedstock per year by 2010 with a 50% cost reduction compared to current technologies baselined in FY03.

Science

INL

Idaho National Laboratory

Laboratory Personnel

The program is supported by a technical staff with varied backgrounds and capabilities, comparable to no other program of its kind. Kevin Kenney and Chris Wright (shown in cover image) are the project leads and technical experts of virtual engineering and computational simulation. Kevin Kenny's expertise also includes particle image velecometry (PIV), software development, separation techniques, and application of virtual engineering tools. Chris Wright is an expert in computational fluid dynamics (CFD), experimental fluid mechanics, and fractionation and densification techniques. Along with support staff and collaborating partners, the INL team is addressing key bioenergy technical barriers captured in DOE Office of Biomass Programs' goals and milestones.

Laboratory Capabilities and Equipment

Key Capabilities:

- Virtual engineering systems simulation and integration
- Experimental and computational fluid dynamics
- Computational stress analysis and fracture mechanics
- Systems engineering and integration

Specialty Equipment:

- Sun-Fire 4800 workstation with 12- 750 MHz CPUs.
- Fluent 6.2.16 computational fluid dynamics software (6 parallel processors)
- ABACAS computational stress analysis software
- Computational simulation system
  - VE-Suite software package
  - 6 ft x 8 ft stereo projection screen
  - 2 image control and user interface processors and hi-fidelity projectors.
- Particle Imaging Velocimetry system
  - Vid-PIV data analysis package
  - High-resolution color digital analog camera
  - Class IV laser-particle illumination system
  - Particle seeding system
- Low volume oscillating biomass separator

Supporting Personnel

The project is supported by skilled personnel in material science, fracture mechanics, agricultural systems design, plant science, microbiology, and high speed imaging. These personnel include Richard Hess, Reed Hoskinson, Pete Pryfogle, Eric Steffler, Richard Williamson, Jeff Lacey, and Mike Daniels of the INL, and Mark Bryden, Doug McCorkle, Dave Muth, and Sunil Suram of Iowa State University.

Publications

K.L. Kenney, C.T. Wright, and K.M. Bryden. 2005. Virtual Engineering Approach to Developing Selective Harvest Technologies. *The 2005 ASAE Annual International Meeting held in Tampa, FL., July 17-20, 2005*.

K.D. Hamman, R.L. Williamson, E.D. Steffler, C.T. Wright, J.R. Hess, and P.A. Pryfogle. 2003. Structural Analysis of Wheat Stems. *The 26th Symposium of Biotechnology for Fuels and Chemicals held in Chattanooga, TN. May 9-12, 2004.*

J.R. Hess, K.L. Kenney, and C.T. Wright. 2003. Image-Based Flow Characterization and Measurement for Biomass Separation Technologies (poster). *The 25th Symposium of Biotechnology for Fuels and Chemicals held in Brekenridge, CO. May 4-7, 2003.*

For more information

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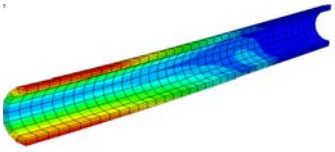

Bending-stress analysis model of wheat straw where red areas show targeted fracture enhancement possibilities induced by equipment loadings.

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